Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	
Comment Sought on Defining "Broadband"	)	GN Docket Nos. 09-47, 09-51 and 09-137
NBP Public Notice #1	)	
	)	

COMMENTS of ADTRAN, Inc.

ADTRAN, Inc. ("ADTRAN") respectfully submits the following comments in response to the Commission's Public Notice, which seeks tailored comment on defining "broadband" for the purposes of the Commission's development of a National Broadband Plan.[1] As a telecommunications equipment manufacturer, ADTRAN has a strong interest in the successful and widespread deployment of broadband to all Americans. ADTRAN has previously addressed some of the same issues in these proceedings, and indeed the Commission cited to some of our earlier submissions in its *Public Notice*.[2] These comments expand upon our previous filings, and are structured as direct responses to the questions posed in the *Public Notice*, with paragraph numbering identical to that in the *Public Notice*.

1. **Forms, Characteristics, and Performance Indicators.**

    a. The definition of broadband should be based on objective and unambiguous metrics, which are applied consistently to any broadband deployment regardless

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1 Comment Sought on Defining "Broadband", *Public Notice*, DA 09-1842, released August 20, 2009 (hereafter cited as "*Public Notice*").

2 *Id.* at fn. 11.

of the underlying technology used to provide access. References to "advertised rates" or other ambiguous or sales-related terms should be avoided.

b. The Commission should develop a single definition for broadband that applies evenly across all types of broadband access. This definition of broadband should be focused on a user's online experience (as measured pursuant to 1(d) below), rather than the underlying technology. In particular, defining broadband based on technology (such as wired vs. wireless) when establishing requirements for publicly funded deployment projects can skew investment away from the solutions that best serve subscribers' needs. See section 1(g) below for additional comments.

c. The metrics used to define broadband should be based in part on the current and anticipated requirements associated with classes of applications. This indirect approach is preferred to a direct applications-based approach, which could prove either unstable or quickly outmoded, depending on how closely the approach tries to track an application landscape which can change nearly overnight.[3]

d. The primary metric used to define broadband should be the **rate capacity per subscriber.** The access network must provide enough capacity, in both the upstream and downstream directions, to meet the traffic demands placed on it by the pool of subscribers it serves. The capacity should be sufficient to handle both diurnal variation in demand and the burstiness inherent in user traffic.

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[3] Floyd, S. and Paxson, V., "Difficulties in Simulating the Internet," *IEEE/ACM Transactions on Networking*, 2001, volume 9, pp 392-403.

Another important characteristic for broadband is **latency,** defined as the minimum delay across the access network in the absence of congestion. A number of important broadband applications, including interactive voice and video and online gaming, require a low latency connection for acceptable performance. Even web browsing is more dependent on latency than on rate for performance in most cases.[4]

The definition of broadband should avoid references to "peak rate." This metric has relatively little value because its relationship to the rate actually observed by the subscriber varies significantly depending on the access network architecture. If the peak rate is limited by a resource dedicated to a single subscriber (such as a digital subscriber line) or by an artificial rate cap that limits the subscriber rate to significantly less that the bandwidth available in any shared resource, then subscribers may frequently experience throughput close to the peak value. In contrast, if it is limited by a resource which is shared by many other subscribers, then throughput close to the peak rate may be a rare occurrence.

e. The scope of each of the metrics listed above should be the access network, defined from the point of demarcation where the access provider's network interfaces with the Internet, to the point of demarcation where the access network interfaces with the customer's network (or computer). This scope encompasses the domain over which the access provider has control over the relevant parameters.

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[4] ADTRAN, *Defining Broadband: An Analysis of Latency in Network Access Architectures*, White Paper, attached to Letter from Stephen L. Goodman, Counsel for ADTRAN, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 09-51 (filed June 23, 2009).

f. As noted in section 1(d) above, the effect of diurnal patterns as well as the burstiness of user traffic should be considered when determining threshold values for per-subscriber capacity. Specifically, per-subscriber capacity thresholds should be determined based on projected demands during the peak usage hours that typically occur during the evening, and should include margin sufficient to accommodate the known burstiness of user traffic with no more than minor or momentary periods of congestion. ADTRAN's White Paper on capacity demonstrates the application of these factors to a process which estimates per-subscriber capacity requirements.[5]

g. The definition of Broadband should not include any differentiation based on the underlying technology (*e.g.*, wired vs. wireless) used to deliver broadband access. A factor matters only if it makes a measurable difference in the quality of a subscriber's online experience (allowing that the quality of the subscriber's experience may be influenced by both technical and non-technical factors, such as cost). If two deployments provide identical quality of online experience (i.e., both consistently provide average throughput capacity capable of supporting key classes of applications), there is no justification for differentiating them based on technology.

h. Each of the performance measures listed in section 1(d) above are verifiable using either network design records, field measurements, or a combination of both techniques. Access providers may find it useful to measure (and possibly report)

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[5] ADTRAN, *Defining Broadband Speeds: An Analysis of Required Capacity in Network Access Architectures*, White Paper, attached to Letter from Stephen L. Goodman, Counsel for ADTRAN, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 09-51 (filed June 23, 2009).

performance using automated tools based on IETF RFC 5357/5618 (Two-Way Active Measurement Protocol or TWAMP).

- Rate capacity per subscriber for wired deployments is the minimum value for *R* on any link carrying the subscriber's traffic in the access network, where *R* is defined as the ratio of total bandwidth to number of subscribers sharing that bandwidth. The parameters required to generate this metric should be available from network design records.

  The above definition also applies to wireless deployments, but it is not complete. The capacity across the wireless portion of the network is more difficult to calculate, as it depends on multiple factors including the duplexing method used, the up/down ratio of the traffic demand, the specific wireless technology and achievable rates across the wireless cell, among other factors. ADTRAN's capacity White Paper[6] shows that as less dense, more robust modulation schemes become necessary with increasing distance from the base station, the per-subscriber capacity averaged over the entire cell drops rapidly. So, even a simplified analysis for wireless capacity must account for rate variation across the cell coverage area – it cannot simply use the maximum rate, available only to those closest to the base station.

- **Latency.** The summed upstream and downstream latency can be measured as the minimum observed round trip transmission time between a device at the customer point of demarcation and a device at the Internet point of

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6 *Id.*

demarcation. The measurement can be as simple as taking the minimum value from a series of "pings."

Note that the minimum latency is measured, rather than a different value such as average or maximum latency. The minimum value provides a fundamental measurement of the propagation delay through the network and this measurement will return consistent values across different times of day and under a broad range of traffic loading conditions. Other variations, such as average or peak delay, are subject to variation based on the user's own traffic as well as that of the rest of the subscriber pool, and a network based on Best Effort service (such as the Internet, as well as the High Speed Internet Access [HSIA] services which provide access to it) can do little to limit peak delay or its effect on the average value. Note that, under all but extreme congestion conditions (which should be both rare and momentary as long as the network provides sufficient capacity per subscriber), the latency experienced by most packets through the access network is very close to the minimum value.[7]

2. Thresholds.

a. The minimum thresholds recommended for broadband access, for each of the performance factors identified in section 1(d), are best developed through industry consensus. ADTRAN discusses below what it believes to be appropriate values.

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[7] ADTRAN, *Defining Broadband: Network Latency and Application Performance*, White Paper, attached to Letter from Stephen L. Goodman, Counsel for ADTRAN, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 09-51 (filed June 23, 2009).

- **Rate capacity per subscriber.** ADTRAN's White Paper regarding capacity[8] contains a detailed analysis which estimates current and projected traffic pro-rated by household for the peak periods defined by diurnal patterns. The traffic data used in the analysis is from Cisco's annual Visual Networking Index[9] and from the University of Minnesota.[10] The projections for required capacity per household, scaled to account for diurnal patterns, bursty traffic, and non-uniform demand, are shown below (Table 5 in the ADTRAN White Paper).

Direction	2009	2012	2015
Down (kbps per household)	350	700	1400
Up (kbps per household)	100	200	400

We recommend that the projected values for the year 2012 (700 kbps per subscriber down, 200 kbps per subscriber up) be adopted as the minimum thresholds for rate capacity per subscriber for broadband access. This recommendation is based on the assumption that the minimum thresholds will be revised every three years based on a new analysis of actual and projected usage. If this revision schedule is not built into the definition, then the

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[8] ADTRAN, *Defining Broadband Speeds: An Analysis of Required Capacity in Network Access Architectures*, White Paper, attached to Letter from Stephen L. Goodman, Counsel for ADTRAN, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 09-51 (filed June 23, 2009).

[9] Cisco, "Cisco Visual Networking Index – Forecast and Methodology, 2007-2012," available at http://www.cisco.com/en/US/netsol/ns827/networking_solutions_sub_solution.html.

[10] Minnesota Internet Traffic Studies, available at http://www.dtc.umn.edu/mints/home.php.

thresholds should be set higher (perhaps as high as the 2015 levels in the above table) to account for the expected growth in demand over time.

- **Latency.** ADTRAN's White Paper regarding latency[11] discusses standards-based requirements for several classes of latency-sensitive applications, and analyses performance based on a latency budget broken out by network segment for each application class. The analysis indicates that latency requirements vary widely by application type. Some applications, such as interactive voice and video, require low latency to meet the desired end-to-end performance. Other applications such as web browsing and file transfer are tolerant of higher latency (although these applications will suffer significant performance degradation with high latency unless techniques such as protocol spoofing are used to compensate). Still other applications such as interactive gaming require the lowest latency possible. As a result, different users may have different needs. A subscriber who primarily uses broadband access for web browsing, streaming video, and email may not need very low latency (subject to the protocol issues mentioned above). In contrast, an online gamer may seek out the lowest latency access available.

  We recommend that latency categories be tiered and identified so as to allow users to make informed choices in line with their needs. There is ample precedent for this approach in the minimum and recommended system requirements guidelines that appear in the specifications for nearly all

[11] ADTRAN, *Defining Broadband: Network Latency and Application Performance*, White Paper, attached to Letter from Stephen L. Goodman, Counsel for ADTRAN, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 09-51 (filed June 23, 2009).

software applications. It may be worthwhile to adopt a tiered system analogous to the system of crashworthiness "stars" – in this case, more "stars" equals lower latency. Such "star ratings" may be aligned with applications classes, rather than providing raw values in ms, to prevent confusion due to the common assumption that "more is better."

We also recommend that access networks with moderate to low latency (below approximately 100-150 ms round trip) be weighted more favorably than networks with high latency in allocation of funding or other processes related to national broadband deployment. ADTRAN believes that networks with high latency (above 100-150 ms) have limited value except where there is no other practical alternative for broadband access. Latency beyond this level precludes truly interactive applications, and limits the performance of most other applications severely unless the protocol issues noted above are addressed.

b. See the discussion in section 2(a) above, which bases the recommended minimum threshold values on requirements applicable to broad classes of applications.

c. See the comments in section 2(a) regarding a tiered approach that may be applied to latency.

3. Updates.

a. We recommend reviewing the definition of broadband on a regular basis with the purpose of revising (or reaffirming) the minimum threshold levels. The traffic volume accessed by the average household has climbed steadily (and rapidly)

over the last decade[12] and that trend is expected to continue. Similarly, the maximum bit rates required by popular classes of applications, such as streaming video, have risen dramatically. Today's threshold values can be expected to be sufficient to meet subscribers' needs for only a few years.

b. We recommend a three year update period. A longer period ignores the rapid pace of change on the Internet, but a shorter period would generate too much churn in the definition.

c. We recommend that the minimum rate capacity per subscriber be reviewed using an analysis similar to that used in ADTRAN's capacity White Paper.[13] Source data for the analyses may come from publicly available data,[14] or it may be solicited from service providers.

d. Adjustments to minimum threshold levels over time will certainly complicate the compilation of meaningful data on broadband deployment – however, those adjustments cannot be avoided if the thresholds are to remain meaningful. If data

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12 *See* ADTRAN, *Defining Broadband Speeds: An Analysis of Required Capacity in Network Access Architectures*, White Paper, attached to Letter from Stephen L. Goodman, Counsel for ADTRAN, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 09-51 (filed June 23, 2009); and Cisco, "Cisco Visual Networking Index – Forecast and Methodology, 2007-2012," available at http://www.cisco.com/en/US/netsol/ns827/networking_solutions_sub_solution.html.

13 ADTRAN, *Defining Broadband Speeds: An Analysis of Required Capacity in Network Access Architectures*, White Paper, attached to Letter from Stephen L. Goodman, Counsel for ADTRAN, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 09-51 (filed June 23, 2009).

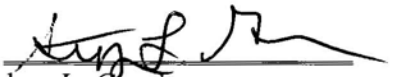
14 Cisco, "Cisco Visual Networking Index – Forecast and Methodology, 2007-2012," available at http://www.cisco.com/en/US/netsol/ns827/networking_solutions_sub_solution.html; Minnesota Internet Traffic Studies, available at http://www.dtc.umn.edu/mints/home.php

is collected regarding the ongoing adoption and replacement of broadband services, including categories for each of the definitions of broadband as they are revised over time, that will support a comprehensive view of broadband adoption that includes not only how quickly new services are adopted, but the degree to which older services are still in use.

ADTRAN believes that the public interest will best be served by evaluating broadband from the multifaceted perspectives described in these comments.

Respectfully submitted,

ADTRAN, Inc.

By: 

Stephen L. Goodman
Butzel Long Tighe Patton, PLLC
1747 Pennsylvania Ave, NW, Suite 300
Washington, DC 20006
(202) 454-2851
SGoodman@butzeltp.com

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